Methods for Model-Based Knowledge Representation in Anatomy

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Learning anatomy means to deal with different representations of knowledge like dissecting a cadaver, studying textbooks and graphics, photographs, or movies, and participate lectures on different topics. To integrate all these information presented by different media is a complex mental task, which forms a more or less correct and complete model of reality. To ease this mental model-building work is a challenge for computer-based educational systems. We aim to increase the range of application of a once developed knowledgebase by using a model, which is independent of a certain knowledge-representation or application but enables the generation or compilation of suitable presentations. We ended up with a concept to model anatomical knowledge based on a symbolic semantic network. The key factor of our design is to use a generic model, which is perfectly independent of any concrete presentation. The translation of this 'unadulterated' knowledge to a specific presentation scheme is managed by performing an instantiation.

In the generic part, objects and their properties are modeled as nodes and their relations as links. The resulting topology is a real net, since any node may have numerous parents and children; even circles appear e.g. when modeling the vascular system. A set of *orthogonal* (independent) dimensions like domains, abstraction level, and special aspects along to the terms and devisions commenly used in anatomy were implemented.

The generic model provides object and link classes on a symbolic level. The link to a concrete representation of an object (*instance*) is provided just by a symbolic description of an instance. Defining instances of a new type easily opens up the whole model for this application.

Our concept opens the chance to analyse and track relationships between objects along to different requirements very easily and therby to supply different applications with context specific informations. A set of powerful functions was implemented to enable free context depending extraction of network information. The generic model up to now is filled with 1800 objects and 3000 links. The content above all covers the domains morphology, cortical functional areas, and blood-supply areas of brain and head. Current projects focus on modeling functional systems, microscopic anatomy, and additional topographic regions.

The model up to know is instantiated for two prototype applications. First, the VOXEL-MAN project, which enables the creation of interactive true threedimensional atlases with a very powerful knowledge-based functionality concerning visualization and exploration of human anatomy. The VOXEL-MAN illustrates how to integrate symbolic and spatial knowledge with "Intelligent Volumes" derived from Computed Tomography and Magnetic Resonance Imaging by instantiate generic objects with segmented objects within the volumes (s. fig. 1).

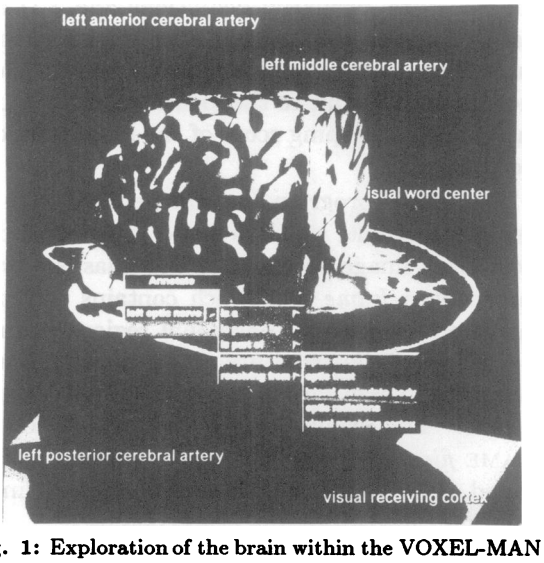

Fig. 1: Exploration of the brain within the VOXEL-MAN atlas. Arbitrary cutting reveals the interior. The user may access all information available on any visible point in space (here the optic nerve) concerning different domains of anatomy.

Second, an example of using the model to handle extended ('intelligent') QuickTime movies. Clicking on any frame of these movies provides a pointer to a specific instantiation of the generic model.

Both applications will be presented and illustrate different aspects of the capability to model, structure, explore, and navigate anatomical knowledge with the described concepts.

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